
CLASS network engineering rules

In a single group network Meridian 1 system, the network internal blocking is determined by the concentration ratio of equipped ports on peripheral equipment and the number of interfaced loops or superloops. Depending on traffic engineering, a non-blocking network is achievable.

In a multi-group system, intergroup junctors are required to switch calls between two network groups. Due to the concentration of time slots from a network group to that of inter-group junctors, blocking may occur. This is true for a multi-group Meridian 1 with or without CLASS (Custom Local Area Signaling Service) sets. However, since the CLASS feature depends on a voice path to deliver CND (Calling Name and Number Delivery) to a set, excessive congestion at the inter-group junctor could block the delivery of CND and diminish the usefulness of the feature, as well as impact the grade of service of the existing equipment on the system.

The following sections will examine the inter-group junctor blocking issue and recommend engineering rules to alleviate potential network congestion problems.

In general, the engineering effort for the CLASS feature can be classified into three categories:

- A new site following engineering rules in section on page 219 requires no inter-group junctor traffic check-off.
- An existing or new site with relatively low inter-group junctor traffic, will require only one XCMC (Extended CLASS Modem Card) IPE pack that can serve all CLASS sets in a multi-group system.
- An existing site with heavy inter-group junctor traffic will require either moving trunks/sets around between network groups when only one XCMC pack is equipped or providing an XCMC pack (or packs) for each group.

This engineering guide recommends that users follow all engineering rules so that network group engineering is not needed. However, if that is not practical for an existing site (or even a new site), the engineering guide will show users when a single XCMC pack can serve a multi-group system with or without re-configuration, and when one pack (or packs) for each group is required.

Meridian 1 multi-group network

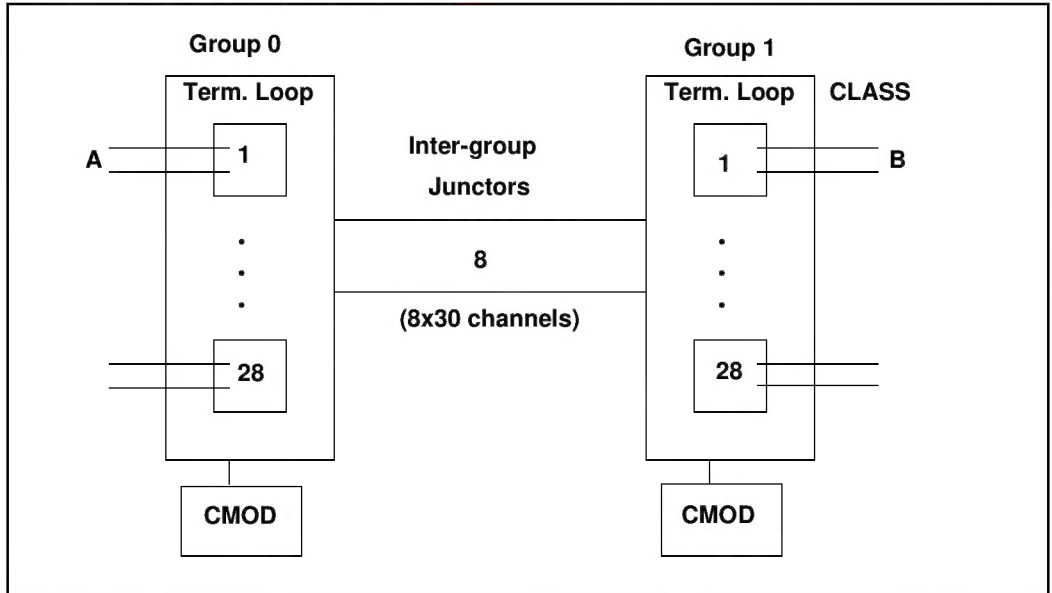
The Option 11C has a network architecture different from the rest of the Meridian 1 Options. It has a non-blocking network and does not require any network engineering (except to use Table 54 CMOD (CLASS MODem) capacity table to find the number of modems needed). A single group Meridian 1 system does not have inter-group junctors; special engineering on junctor is not applicable. Therefore, this document is only relevant to a Meridian 1 Option with a multi-group network.

In general, inter-group junctor blocking is most severe when there are only two groups, since under typical traffic distribution assumptions, 50% of calls will stay in the originating group and 50% will terminate on the second group through junctors, unless a Community Of Interest (COI) is known and taken into consideration in engineering to minimize inter-group traffic.

Under the assumption of even distribution of traffic, the percentage of traffic to an inter-group junctor will drop to 33.3% of the total group traffic for a 3-group system. Similarly, the junctor traffic will be 25% of group traffic for a 4-group system and 20% for a 5-group system.

A simplified Meridian 1 with two-group network and CLASS sets is shown in [Figure 12](#).

Figure 12
Meridian 1 with a two-group network



Note that traffic to a CLASS set can be originated from a non-CLASS set, another CLASS set or an incoming trunk. Since trunks have more traffic impact on junctor blocking, they are used to illustrate the feature operation, however, both sets and trunks can be traffic sources to CLASS sets.

The maximum size Meridian 1 comprises of 5 network groups. Each group has 32 loops of which 28 can be terminal loops, the rest are service loops (TDS loops for tones, conference and music).

From Group 0 to Group 1 as shown in [Figure 12](#), there are 8 one-way junctors. Similarly, there are another 8 one way junctors from Group 1 to Group 0. For practical purposes, they can be treated as 8 two-way junctors. A two-way path is equal to a voice channel. A junctor has 30 voice traffic channels as on a loop. Each two-way channel represents a conversation path. A channel is also used to deliver the CND from the CMOD to a CLASS set.

CLASS Feature Operation

A call originated from Set A (or trunk A) seeks to terminate on a CLASS set B. When B starts to ring, A will hear ringback. A unit in CMOD (CLASS Modem) is assigned to collect originator's CND information and waits for the CND delivery interval. After the first ring at B, a silence period (delivery interval) ensues, the CMOD unit begins to deliver CND information to the CLASS set.

The CND information of a traffic source (A) is a system information, which is obtained by the system when a call is originated. During the 2-second ringing period of the CLASS set B, A's CND is delivered to CMOD via SSD messages (using signaling channel only). When the CND information is sent from CMOD to CLASS set B, it is delivered through a voice path during the 4-second silence cycle of set B. The CMOD unit is held for a duration of 6 seconds.

If the XCMC (Extended CLASS Modem Card) IPE pack, which provides up to 32 CMOD units, is located in the IPE of Group 0, the CMOD unit in the pack will receive CND data through the SSD messages and use one of the voice channels of the inter-group junctor to deliver it to CLASS set B in Group 1.

If the XCMC IPE pack is located in Group 1, the system will deliver SSD messages containing CND information to CMOD and then send it to Set B during the delivery interval through a voice path, which is an intra-group channel not involving an inter-group junctor.

When CMOD units and CLASS sets are co-located in the same network group, there are no voice paths on the inter-group junctor required to deliver CND information; when they are equipped on different groups, inter-group junctors must carry CND traffic. The resource allocation algorithm will search for a CMOD unit located in the same group as the terminating CLASS set first before it attempts to use a CMOD unit from a different group.

Inter-group Junctor Capacity

The time slot allocation algorithm for inter-group junctors is somewhat different from regular network loops, however, it is a close approximation to use the network loop capacity for junctor capacity, since they each have 30 traffic channels.

In order for the connection between a CMOD unit and the remote set (on a different group) to meet the Grade Of Service (GOS) of Meridian 1 for internal call setup, traffic on the loop and inter-group junctor should meet normal GOS requirements, that is 660 CCS per loop or junctor.

If we let an inter-group junctor be loaded to 660 CCS like a loop, the total allowed traffic at eight junctors is 5280 CCS ($=660 \times 8$). At 6 CCS per CLASS set, the allowed number of sets generating inter-group traffic is 880 ($=5280/6$). If half of set traffic is intra-group, and the other half inter-group, the allowed number of CLASS sets in Group 1 is 1,760 ($=880/0.5$). On per loop basis, each loop can be equipped with 62 ($=1760/28$) CLASS sets.

Similarly, a 3-group network is likely to have 1/3 of traffic remaining in the group, 1/3 of traffic going to the next group, and another 1/3 of calls going to the third group. By using this inverse proportion approach to breakdown traffic flow at junctors, the capacity of a network group in terms of CLASS sets is summarized in [Table 89](#). The entry in [Table 89](#) is the threshold for inter-group junctor traffic check-off.

The table entry indicates that in a two group system, the second group is allowed to have 1760 CLASS sets or a combination of CLASS and equivalent sets without a need to move sets or trunks around to reduce inter-group junctor traffic. Due to higher traffic, an agent set or a trunk is counted to be equal to 4 regular sets. The conversion needs to be done before using [Table 89](#).

If the number of equipped sets (CLASS or otherwise) or equivalent sets (sets converted from trunks and agent sets) is less than the threshold, the junctor traffic is expected to be low. There is no special engineering necessary for CLASS sets (other than providing required modems).

Note that the junctor traffic issue can be ignored if each group is fully equipped with sufficient CMOD units to handle CLASS sets within the group. It is the attempt to use one XCMC pack to serve multiple groups that requires special attention to inter-group traffic. As long as CLASS service is not impacted by an existing traffic imbalance, it is not the objective of this engineering guide to solve the general network engineering problem.

Once the threshold is exceeded, re-configuration of the system is necessary to reduce junctor congestion. The detailed engineering rules are given in the next chapter.

Table 89

Maximum CLASS sets per group (based on inter-group junctor capacity limitation)

Number of groups	Sets/Groups
2	1760
3	2933
4	3520
5	4080

Note: Convert a trunk or an agent set to 4 equivalent sets before applying the above table.

A single group system can have as many CLASS sets as each loop allows. The engineering of Meridian 1 is not different from that of non-CLASS sets, since there is no inter-group junctor involved. The only engineering needed is to find the required number of CMOD units from [Table 90](#) to serve a given number of CLASS sets.

Note that the capacity per group for multigroup systems assumes no trunking in that particular group (or that trunks have been converted to equivalent sets). Therefore, the total system capacity, when taking into account trunks, agent sets and service circuits, will not be as large as a straight multiple of the number of groups by the number of sets per group.

The number of allowed CLASS sets per group in [Table 90](#) is strictly a function of inter-group traffic (except for 5-group systems). When a system becomes 5-group, the junctor capacity is no longer a bottleneck under the assumption of even traffic distribution. The system capacity will become unrealistic if it is purely based on the inter-group junctor capacity, therefore, other system resources, particularly the system CPU, need to be checked. The number 4080 is based on loop traffic (28 loops/7 superloops), not junctor capacity.

If a group comprises of both regular sets and CLASS sets, the total number of sets in the group should not exceed the quoted number in the table. If trunks and agent sets are included in the group, convert them to “equivalent sets” before using Table 90. More details are described in the engineering guide.

Table 90 is the CMOD capacity table. It provides the number of CMOD units required to serve a given number of CLASS sets with the desired grade of service (P.001). The required number of CMOD units should have a capacity range whose upper limit is greater than the number of CLASS sets equipped in a given configuration.

Table 90
CMOD Unit Capacity Table (P.001)

CLASS Set	1-2	3-7	8-27	28-59	60-100	101-150	151-206	207-267
CMOD Unit	1	2	3	4	5	6	7	8
CLASS Set	268-332	333-401	402-473	474-548	549-625	626-704	705-785	786-868
CMOD Unit	9	10	11	12	13	14	15	16
CLASS Set	869-953	954-1039	1040-1126	1127-1214	1215-1298	1299-1388	1389-1480	1481-1572
CMOD Unit	17	18	19	20	21	22	23	24
CLASS Set	1573-1665	1666-1759	1760-1854	1855-1949	1950-2046	2047-2142	2143-2240	2241-2338
CMOD Unit	25	26	27	28	29	30	31	32
CLASS Set	2339-2436	2437-2535	2536-2635	2637-2735	2736-2835	2836-2936	2937-3037	3038-3139
CMOD Unit	33	34	35	36	37	38	39	40
CLASS Set	3140-3241	3242-3344	3345-3447	3448-3550	3551-3653	3654-3757	3768-3861	3862-3966
CMOD Unit	41	42	43	44	45	46	47	48
CLASS Set	3967-4070	4071-4175	4176-4281	4282-4386	4387-4492	4493-4598	4599-4704	4705-4811
CMOD Unit	49	50	51	52	53	54	55	56
CLASS Set	4812-4918	4919-5025	5026-5132	5133-5239	5240-5347	5348-5455	5456-5563	5564-5671
CMOD Unit	57	58	59	60	61	62	63	64

General Engineering Guidelines

Non-Call Center Applications

In a non-call center application, there is no significant number of agent sets. Therefore, no agent set to regular set conversion is needed.

Configurations following engineering rules (no re-configuration required)

- The following engineering rules should be followed to avoid the need to re-configure a switch to accommodate the CLASS feature.
- Provide the number of CMOD units serving all CLASS sets in the system based on the capacity table (Table 54).
- Equip all CLASS sets in one network group.
- Equip the XCMC IPE pack on the network group with CLASS sets.

If the system is a single group system, or if above rules are fully met, no further engineering is necessary. However, in case of an existing multi-group site upgrading to provide CLASS feature, we may need to re-configure the system in order to satisfy rules.

When above rules are not fully met, continue the system engineering by following the procedure in the next subsection.

Re-configuration may be required (when engineering rules are not fully followed)

When the above rule can not be satisfied in a new site or an existing one, the following guidelines are designed to (1) minimize network blocking, and (2) determine whether a re-configuration (to move trunks and sets around), or the provisioning of an XCMC pack per group is necessary.

- To use [Table 90](#) to estimate CMOD unit requirements, consider only CLASS sets (no trunks or non-CLASS sets).
- If CLASS sets are equipped in more than one group, locate the XCMC IPE pack in the group with the most CLASS sets.
- Use [Table 90](#) to decide whether re-configuration is required. For a network group with trunks, regular sets and CLASS sets, convert trunks to sets by using the formula: 1 trunk = 4 sets (called equivalent sets), and then add up the total.
- Check threshold in [Table 90](#). If the number of equivalent sets is less than 1760 (e.g., for a 2-group system), there is no need to re-configure the system.
- If the number is greater than 1760, we need to (1) move some of the CMOD units to a second XCMC IPE pack on another group (when CLASS sets are scattered in two groups), or (2) move some sets or trunks from one group to another group to satisfy the threshold.

The following examples will show some of the engineering details of dealing with various alternatives.

To simplify discussion, the network group 0 has a minor number of CLASS sets. The majority of CLASS sets are in group 1 (refer to Figure 2).

Engineering Examples**One XCMC pack serving a single group system**

No special engineering rule is needed for a single group system (Meridian 1 Option 51C or 61C). Refer to [Table 90](#) to find the required number of CMOD units to serve the given CLASS sets. For example, to serve an Option 61C with 400 CLASS sets, use [Table 90](#) to find the number of CMOD units serving a range that includes 400 sets. The result is 10 units which can serve from 333 to 401 CLASS sets.

One XCMC pack serving a 2-group system**Example 1: No re-configuration**

A 2-group Meridian 1 system serving an office is expected to convert 400 analog sets to CLASS sets. Currently, 100 of them are located in group 0, where all incoming trunks are located, and the remaining 300 sets are in group 1. Assume that group 1 is also equipped with 800 non-CLASS sets. How many CMOD units are needed to serve this application and does the customer need to re-configure the switch (move sets and trunks between group 0 and group 1) to do the upgrade?

Solution:

- The table lookup indicates that 400 CLASS sets need 10 CMOD units. Since one pack provides 32 units, one XCMC pack is sufficient for this customer.
- Group 1 is equipped with 300 CLASS sets which is greater than the 100 sets in group 0, the pack should be installed in group 1.
- The total equipped ports in group 1 is 1100 (=800+300). For a 2-group system, the second group is allowed to have 1760 sets (from [Table 90](#)) without junctor traffic concerns, therefore, there is no need for the customer to re-configure the switch.

Example 2: Re-configuration

A similar application as in the last example, except that there are 1600 non-CLASS sets and 100 trunks in group 1.

Solution:

- The same number of CMOD units (10), since the number of CLASS sets in the system is the same.
- The number of total equivalent sets in group 1 is 2300 ($=1600 + 300 + 100 \times 4$) which is greater than the 1760 threshold in the Table 90 for a 2-group system.
- The customer will have a number of alternatives to resolve the junctor blocking issue, depending on the situation: (1) move the 100 CLASS sets from group 0 to group 1, so all CLASS sets are served by the XCMC pack in group 1, or (2) move the 300 CLASS sets and the XCMC pack to group 0, or (3) move 540 non-CLASS sets ($=2300-1760$) from group 1 to group 0, or (4) move 100 CLASS sets from group 1 to group 0 and split the 10 CMOD units to 5 for group 0 and 5 for group 1; however, this will require another XCMC pack to be equipped in group 0. The cost of this approach is not trivial. It can be justified only when growth plan indicates a need for a second pack in the near future anyway.

The final decision depends on the specific situation of a site.

Call Center Applications

Configurations following engineering rules (no re-configuration required)

The following engineering rules should be followed to avoid the need to re-configure a switch to accommodate the CLASS feature for call center environment.

- Convert an agent set to regular set by using 1 agent CLASS set = 4 sets (called equivalent sets)
- Sum up the total number of regular CLASS sets and equivalent CLASS sets and find the number of CMOD units required based on the capacity table (Table 54).
- Equip CLASS agent sets in the group where trunks carrying incoming traffic to agent sets are located.
- Equip non-agent CLASS sets in the same group as the agent CLASS sets.
- Equip the XCMC IPE pack on the network group with CLASS sets.

If the system is a single group system, or if above rules are fully met, no further engineering is necessary.

In case of an existing multi-group site upgrading to provide CLASS feature, re-configuring the system may be necessary.

When above rules are not fully met, continue the system engineering by following the procedure in the next subsection.

Configurations do not fully meet engineering rules (re-configuration may be required)

When above rules can not be satisfied in a new site or an existing one, the following guidelines are designed to (1) minimize network blocking, (2) determine whether a re-configuration (to move trunks and sets around) is necessary, or (3) determine whether separate XCMC packs are necessary to serve the multi-group system.

- Convert an agent set to regular set by using 1 agent CLASS set = 4 sets.
- Sum up the total number of equivalent CLASS sets and find the number of CMOD units required based on the capacity table (see [Table 90](#)).
- Equip the XCMC IPE pack on the network group with most CLASS sets (or equivalent sets).
- Limit the number of agent CLASS sets to be 200 or less per group.
- Limit the number of regular CLASS sets in a group without XCMC pack to be 100 or less.
- Convert trunks (1 trunk = 4 sets), and agent set (1 agent set = 4 sets) to equivalent sets before using [Table 90](#) to find junctor traffic threshold.
- If the threshold in [Table 90](#) is greater than the total number of equivalent sets, traffic in the system is balanced, and there is no need for further network engineering.
- If the number of equivalent set is greater than the threshold, one or all of the following engineering rules should be followed to reduce junctor traffic:

Move sets (CLASS or non-CLASS) or trunks to another group to satisfy the above engineering rules.

Equip XCMC pack in more than one group to serve local CLASS set traffic.

- When a trunk route is known to serve only agent sets, and these trunks and agent sets are in the same group, exclude them from the set count in [Table 90](#) threshold (e.g., do not include trunks and agent sets with known COI when using [Table 90](#), since they do not generate traffic to junctors).

The following examples will show some of the engineering details of dealing with various alternatives.

To simplify discussion, the network group with most trunks is called group 0, consequently, a majority of CLASS sets, if not all, are in group 1. If most agent CLASS sets and XCMC pack are in group 0, there will be no need for further engineering.

Engineering Examples

One XCMC pack serving a single group system

No special engineering rule is needed for a single group system. Look up [Table 90](#) to find the required number of CMOD units to serve the given CLASS sets. For example, to serve an Option 61C with 300 agent CLASS sets, use [Table 90](#) to find the CMOD units that can serve 1200 equivalent sets ($=300 \times 4$). The result is 20 units.

One XCMC pack serving a 2-group system

Example 1: No re-configuration required

A 2-group Meridian 1 system serving a call center is expected to upgrade 300 analog sets (100 administrative sets and 200 agent sets) to CLASS sets. The 100 administrative sets are located in group 0, where are also located all incoming trunks. The 200 agent sets are in group 1, which will continue to be used as agent sets after upgrading. Assume that group 1 is also equipped with 500 non-CLASS sets. How many CMOD units are needed to serve this application and does the customer need to re-configure the switch (move sets and trunks between group 0 and group 1) to do the CLASS feature upgrade?

Solution:

- The table lookup indicates that 900 equivalent CLASS sets ($=100+200 \times 4$) need 17 CMOD units. Since one pack provides 32 units, one XCMC pack is sufficient for this customer.
- Group 1 is equipped with 200 agent CLASS sets or 800 equivalent sets which is greater than the 100 sets in group 0, the pack should be installed in group 1.

The total equipped ports in group 1 is 1300 ($=200 \times 4 + 500$). For a 2-group system, the second group is allowed to have 1760 sets (from Table 90) without junctor traffic concerns, therefore, there is no need for the customer to re-configure the switch.

- In addition, both “100 CLASS sets in a group without CMOD units (group 0)”, and “200 agent CLASS sets in a group separate from incoming trunks (group 1)” statements are within engineering rules, therefore, no re-configuration is necessary.

Example 2: Re-configuration required

A similar application as in the last example, but there are 1600 non-CLASS sets in group 1.

Solution:

- The same number of CMOD units (17) is required, since the number of equivalent CLASS sets (900) in the system is the same.
- Equip the 17 CMOD units in group 1, since the XCMC pack should be equipped in the group with the most CLASS (equivalent) sets.
- The number of total equivalent sets in group 1 is 2400 ($=1600+200 \times 4$) which is greater than the 1760 threshold in the Table 90 for a 2-group system.
- The customer will have a number of alternatives to resolve the junctor blocking issue, depending on the situation:

Move the 100 CLASS sets from group 0 to group 1. Or

Equip the 200 CLASS agent sets and the XCMC pack in group 0. Or

Move 640 non-CLASS sets ($=2400-1760$) from group 1 to group 0 to avoid threshold violation. Or

Move 100 CLASS sets from group 1 to group 0 and split the 17 CMOD units to 10 for group 0 and 7 for group 1; however, this will require another XCMC pack to be equipped in group 0. Or

Move 160 trunks with COI to agent sets from group 0 to group 1, so that the total equivalent sets in group 1 will become 1760 ($=1600+(200-160) \times 4$), since this way the 160 trunks and an equal number of agent sets will not generate traffic to junctors.

The final decision depends on the specific situation of a site.

Example 3: Mixed sets, trunks in both groups and re-configuration required

A 2-group Meridian 1 system serving a call center is expected to equip 200 administrative CLASS sets in group 0 and 400 CLASS agent sets in group 1. 500 trunks carrying incoming traffic to agents are located in group 0, 60 trunks serving local CO non-ACD traffic are equipped in group 1. Assume that group 1 is also equipped with 300 non-CLASS sets. Can this configuration meet engineering rules? How many CMOD units are needed?

Solution:

- The equivalent CLASS sets in system = $200 + 400 \times 4 = 1800$. From Table 54, 27 CMOD units are needed. It requires the XCMC pack to be equipped in group 1.
- When we equip the XCMC pack in group 1, there are three violation of rules: (1) the number of CLASS sets in the group without CMOD units (group 0) is greater than 100, (2) the number of agent sets in a group without incoming trunks (group 1) is 400 which exceeds the 200 per group limit, and (3) the violation of threshold in Table 90 for group 1 ($=400 \times 4 + 60 \times 4 + 300 = 2140 > 1760$). Several alternatives are available to make this configuration meeting engineering rules:

Move 100 CLASS sets and 400 incoming trunks from group 0 to group 1; all above 3 violations are removed by this re-configuration: (1) CLASS sets in group 0 is 100, (2) 400 CLASS agent sets and 400 incoming trunks with COI are in the same group (group 1), (3) the number of equivalent sets in group 1 for threshold check-off is reduced to 640 ($=100 + 60 \times 4 + 300 = 640$) which is certainly within the limit (1760).

However, it is impractical to put almost all trunks and agent sets in one group (group 1). With so many rule violations, the most realistic approach is to move 200 CLASS agent sets to group 0 and equip approximately 15 CMOD units in group 0 and 12 units in group 1.

One XCMC pack serving a 3-5 group system

Chances of groups larger than 3 requiring special engineering are slim, since the threshold in [Table 90](#) limiting the number of sets per group is much higher.

If the rule of co-locating CLASS sets and CMOD units in the same group is not fully met, as long as the basic rule of putting XCMC pack in the group with the most CLASS sets is followed, perhaps, no re-configuration between any two groups is necessary.

If in doubt, isolate any two groups at one time, and go through the 2-group engineering procedure to re-configure the system two groups at a time. Ignore the rest of system during the engineering process, except for calculating the total number of CMOD units, which should cover the need of all CLASS sets in the system. However, during a 2-group engineering, only the number of CMOD units attributable to the 2-group at hand should be used in calculations.

Also remember to use 2933 (equivalent) sets per group for threshold check-off for the 3-group system, and their respective number for 4- and 5-group systems (see [Table 90](#)).

The complete check-off of set thresholds between any two groups in a multi-group system can be represented by the following combinations (a number denotes the group number: e.g., 1-2 represents group 1-group 2):

3-group: 1-2, 1-3, 2-3.

4-group: 1-2, 1-3, 1-4, 2-3, 2-4, 3-4.

5-group: 1-2, 1-3, 1-4, 1-5, 2-3, 2-4, 2-5, 3-4, 3-5, 4-5.

It should be noted that although CMOD units are equipped according to the traffic requirement of CLASS sets in a network group for the inter-group junctor traffic consideration, they are a system resource shared by the whole system.

